DMT
DANISH MYO TECHNOLOGY

MUSCLE STRIP MYOGRAPH SYSTEM

MODEL 820MS

User Manual

Version 1.2

MUSCLE STRIP MYOGRAPH SYSTEM
MODEL 820MS

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This documentation is provided with the DMT Muscle Strip Myograph System – Model 820MS

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INTRODUCTION

The Muscle Strip Myograph System - 820MS represents the first state-of-the-art 4-channel myograph system for muscle strips of up to 15 mm in length. DMT developed this system for simultaneous measurement of up to 4 isolated muscle preparations, mounted as strips, between clamp supports. Several types of mounting supports exist, depending on the user's preferences. Customized mounting supports can be made upon request. In addition, because of the somewhat rectangular chamber, the myograph also can be used for the study of larger strips from other organs, including larger, longer strips of smooth muscle.

Stimulation electrodes are available (optional). The electrodes are built into the chamber cover and can be used to activate the muscle via field stimulation from a pulse/train stimulator, such as the DMT CS200.

The muscle bath unit is constructed of aluminum, while the centrally located rectangular chamber is stainless steel for easy cleaning. The segment clamp supports are positioned in the chamber with one side attached to a force transducer and the other side to a micro-manipulator. The micromanipulators permit the accurate setting of passive tension (which correlates with muscle length) while the sensitive force transducers measure the developed isometric muscle tension during stimulation. Each unit has individually controlled gas inflow and suction. The system is automatically heated to a set temperature, up to 45° C.

Following mounting and equilibration, the optimal pre-load or passive tension for the muscle can be determined. The length of the muscle is kept constant during the experiment; thereby any contractions measured from the isolated, mounted muscle strip will be examined under isometric conditions. Compounds can be added directly to the chamber, and muscle tension can be monitored to evaluate the chronotropic or inotropic effects of the compound. If desired, the buffer can be sampled for metabolic factors during and after muscle contraction(s).

This myograph is well-suited for high-throughput analysis of muscle reactivity, especially when multiple units are arranged conveniently side-by-side. The 820MS is ideal for drug development and testing related to striated muscle, as well as for experiments where comparing multiple muscle samples from control and treated or gene-modified animals is required. The multitude of data generated from the force transducers can be captured through external data acquisition via either calibrated (filtered) or uncalibrated (unfiltered) analog outputs or in digital format via a serial connection.

SAFETY

The Muscle Strip Myograph System - 820MS has been designed for use in teaching and research only. It is not intended for clinical or critical life-care use and should never be used for these purposes. The 820MS also should not be used for the prevention, diagnosis, curing, treatment, or alleviation of disease, injury, or handicap. The following are other safety concerns of note:

- Do not open the unit; the internal electronics pose a risk of electric shock.
- Do not use this apparatus near water.
- To reduce the risk of fire or electric shock, do not expose this apparatus to rain or moisture. Objects filled with liquids should not be placed on the system.
- Do not block any ventilation openings. Install in accordance with the manufacturer's instructions.
- Do not install near any heat sources such as radiators, heat registers, stoves, or other items that produce heat.
- Only use attachments and accessories specified by the manufacturer.
- Unplug this system during lightning storms or when unused for long periods of time.
- Be advised that different operating voltages require the use of different types of line cord and attachment plugs. Check the voltage in your area and use the correct type. See the table below:

Voltage	**Line plug according to standard**
110–125 V	UL81 and CSA C22.2 No. 42
220–230 V	CEE 7 page VII, SR section 107-2-D1/IEC 83, page C4
240 V	BS 1363 of 1984 Specification for 13A fused plugs and switched and unswitched socket outlets.

Protect the power cord from being walked on or pinched: particularly at power plugs and the point where they connect to the apparatus.

Refer all servicing to qualified service personnel. Servicing is required when the apparatus has been damaged in any way; such as, the power-supply cord or plug is damaged, liquid has spilled onto or objects have fallen into the apparatus, the apparatus has been exposed to rain or moisture, does not operate normally, or has been dropped.

EMC / EMI

This equipment has been tested and found to comply with the limits for a Class B Digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in residential installations. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception (which can be determined by monitoring the interference while turning the equipment off and on), the user is encouraged to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different to that which the receiver is connected to.
- Consult the dealer or an experienced radio/TV technician for help.

APPROVALS

Complies with the EMC standards:

EMC 89/336/EEC:	EN 61326-2-6:2005
	EN 61000-3-2.

Certified with the safety standards:

Directive 2006/95/EC:	EN 61010-1:2001
	EN 61010-1/Corr.1:2003
	EN 61010-1/Corr.1:2003
	EN 61010-2-101:2003

CERTIFICATE OF CONFORMITY

DMT A/S, Skejbyparken 152, 8200 Aarhus N., Denmark,
hereby declares its responsibility that the following product:

Muscle Strip Myograph System
Model 820MS

is covered by this certificate and marked with CE-label conforms with the following standards:

EN 61010-1:2001 EN 61010-1/Corr.1:2003 EN 61010-1/Corr.1:2003	Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements.
EN 61010-2-101:2003	Safety requirements for electrical equipment for measurement, control and laboratory use - Part 2-101: Particular requirements for in vitro diagnostic (IVD) medical equipment.
EN 61326-2-6:2005	Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 2-6: Particular requirements - In vitro diagnostic (IVD) medical equipment.
	With reference to regulations in the following directives: 2006/95/EC, 89/336/EEC

ABOUT THIS MANUAL

This manual contains a complete list of procedures that describe how to install, maintain and use the Muscle Strip Myograph System – 820MS.

Chapter 1 provides an overview of the construction and basic features of the Myo-Interface and the myograph unit.

Chapter 2 describes step-by-step how to set-up the complete Muscle Strip Myograph System – 820MS including accessories.

Chapter 3 is a complete manual to the Myo-Interface. The chapter describes in detail the construction of the menu system and how to use all the features of the Muscle Strip Myograph System - 820MS.

Chapter 4 contains procedures describing general as well as daily maintenance of the myograph unit; e.g. adjustment of supports and cleaning instructions.

Appendix contain system specifications.

UNPACKING THE MYOGRAPH SYSTEM

Take a few minutes to carefully inspect your new Muscle Strip Myograph System - 820MS for damage which may have occurred during handling and shipping. If you suspect any kind of damage, please contact DMT immediately and the matter will be pursued soon as possible. If the packing material appears damaged, please retain it until a possible claim has been settled.

We recommend that you store the packing material for any possible future transport of the Muscle Strip Myograph System. In case of transport and the original packing material is unavailable, please contact DMT Sales Department for advice and packing instructions.

After unpacking your new Myograph System, please use the following list to check that the system is complete:

- 1 interface unit
- 4 chamber units with mounted clamp supports
- 4 chamber covers
- 1 external temperature probe
- 1 power cord*
- 1 calibration kit (including bridge, balance and 2 g weight)
- 1 tube of high vacuum grease
- 1 tube of grease for screw thread
- 2 Allen keys
- 1 small screwdriver
- 1 CD with an user manual for Muscle Strip Myograph System

** The shape of the AC plug varies by country; be sure that the plug fits the outlets for your location.*

CHAPTER 1 - SYSTEM OVERVIEW

1.1 Myo-Interface front panel

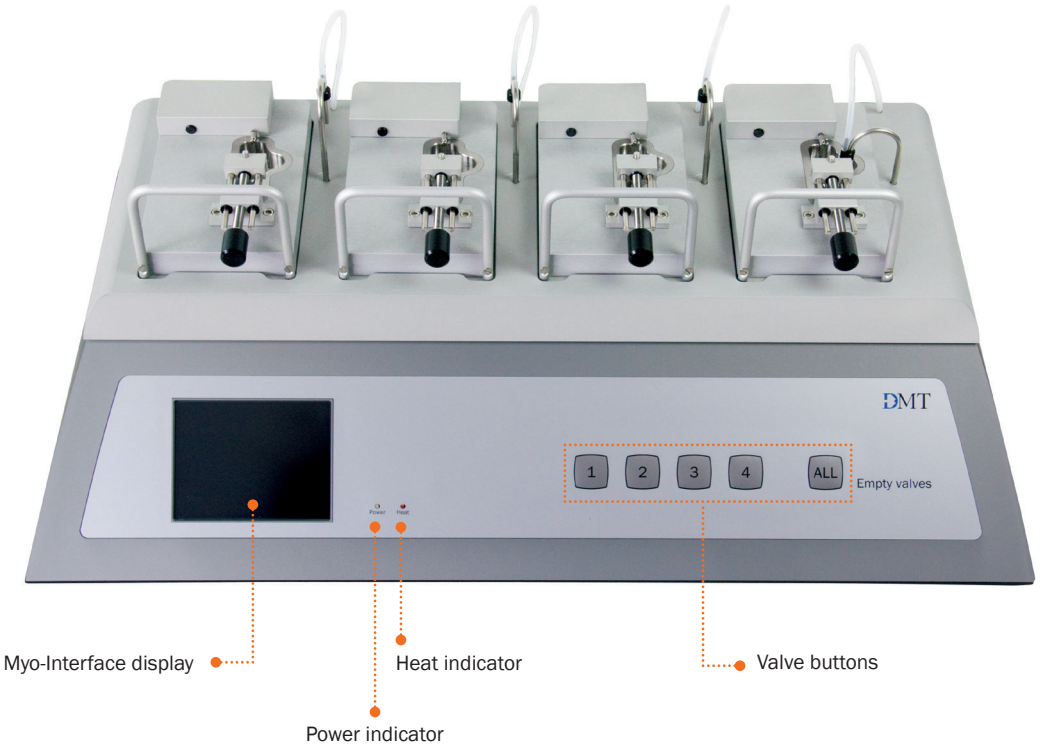


Figure 1.1 *- Interface Front Panel with 820MS chambers*

1.2 Interface Rear Panel

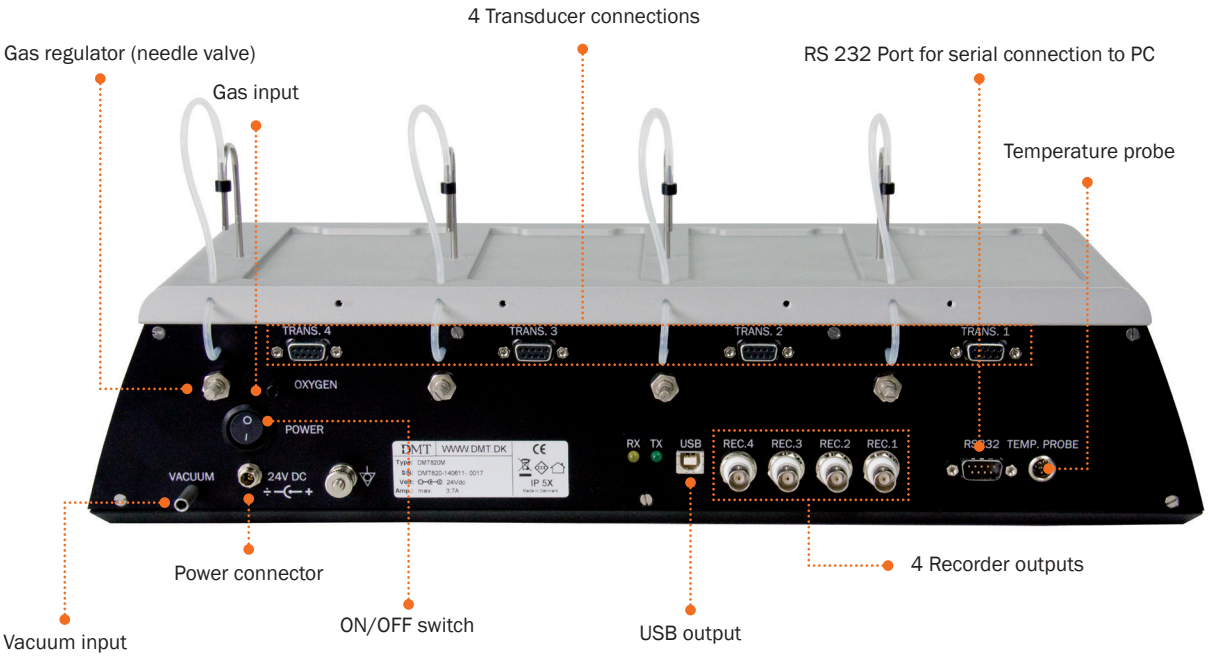


Figure 1.2 *Interface Rear Panel*

1.3 Muscle Strip myograph unit

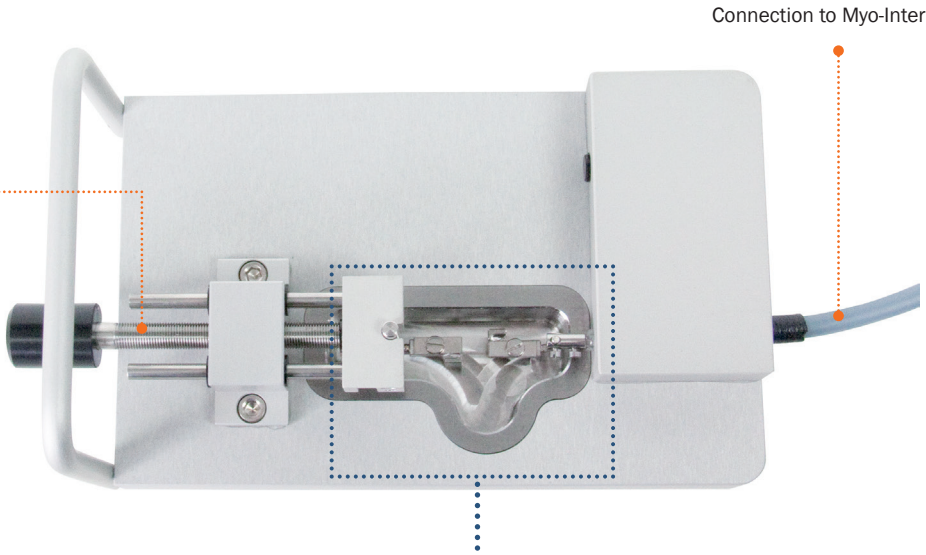


Figure 1.3 *Muscle Strip myograph unit*

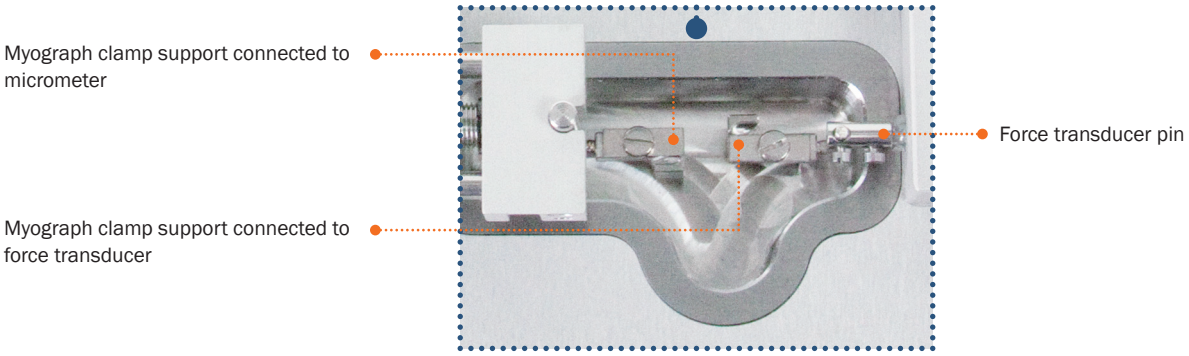

Myograph clamp support connected to micrometer
Force transducer pin
Myograph clamp support connected to force transducer

Figure 1.4 *Close up of myograph unit*

CHAPTER 2 - SETTING-UP

2.1 The complete Muscle Strip Myograph System - 820MS

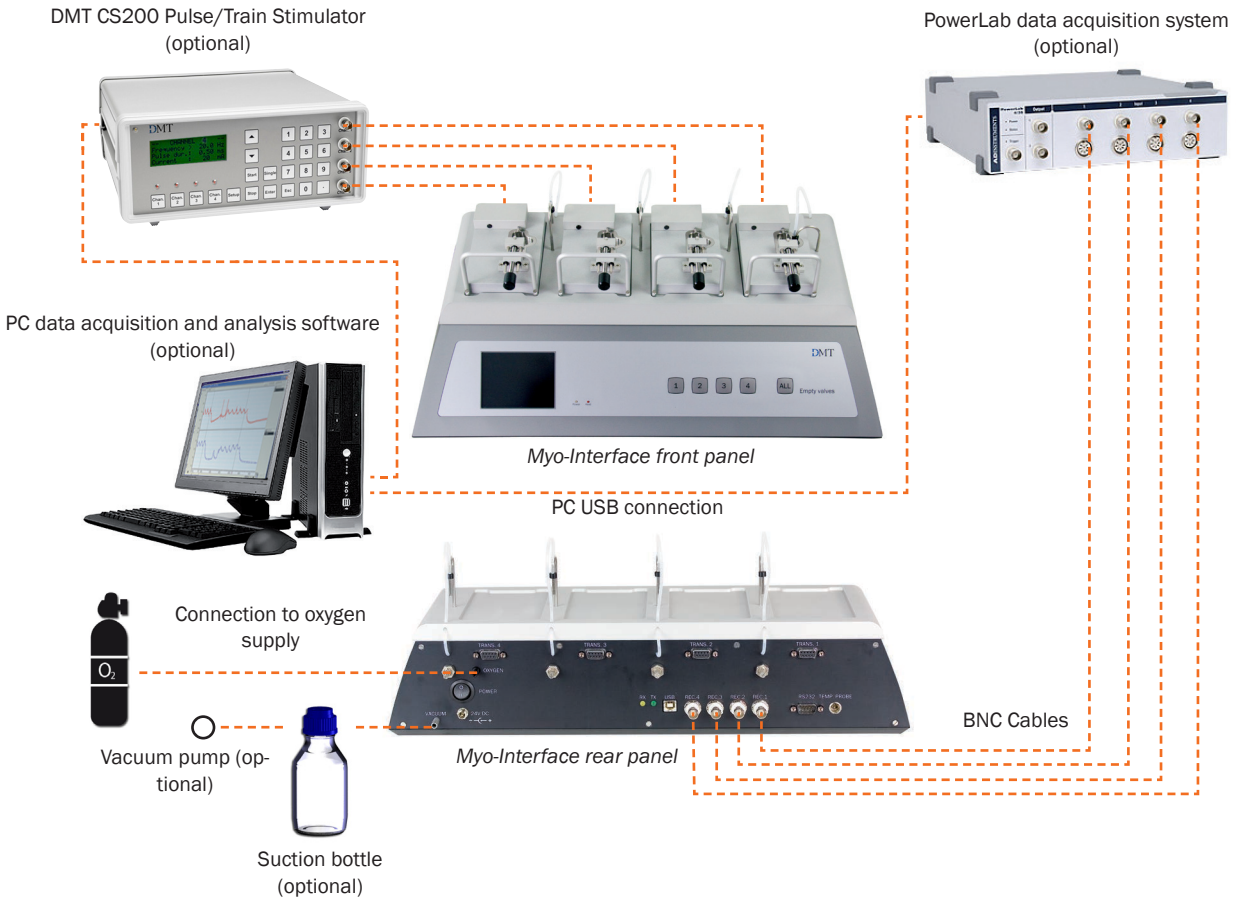


Figure 2.1 *The complete Muscle Strip Myograph System - 820MS*

2.2 Setting up step-by-step

This chapter contains a complete step-by-step description of how to set up a complete Muscle Strip Myograph System - 820MS as illustrated in figure 2.1 above.

1. **Interface – PC Connection**
   Data acquisition is possible either by connecting the Interface directly to a PC or through a PowerLab data acquisition and analysis system (optional).

   I. **Direct PC Connection**
   Connect the Interface to one of the COM-ports on the PC using a serial cable (cable not included).

   II. **PowerLab (Optional)**
   Connect the Interface to the PowerLab unit using BNC cables. Connect Rec 1 on the Interface to Input 1 on the PowerLab, Rec 2 to Input 2 etc. Connect the PowerLab unit to one of the USB ports on the PC using the USB cable delivered with the PowerLab system.

2. **Oxygen supply**
   Connect the gas supply (95% O_2, 5% CO_2 or 21% O_2, 5% CO_2, balance N_2) with tubing running from the gas supply to the gas inlet on the back of the Interface. Oxygen is supplied to the chambers by tubing attached to the stainless steel vacuum pipe. e oxygen and vacuum tubing need to be inserted into the chamber in order to aerate the heated buffer. Needle valves on the back of the interface can be adjusted to regulate the amount of bubbling that occurs. Turning the regulator clockwise increases the bubbling while turning it counter-clockwise decreases the bubbling. Each regulator has a lock device attached that can be used when the desired bubbling is achieved (“Figure 2.2 - Oxygen supply and suction connection” on page 14).

NOTE: THE NEEDLE VALVES NEED TO BE GREASED (USING THE GREASE FOR THE LINEAR SLIDES) AND TURNED AT REGULAR INTERVALS TO PREVENT THEM FROM STICKING OR PERMANENTLY FREEZING.

3. **Vacuum Connection**
   The system has a built-in manifold with separate valves that allows each chamber to be drained individually. After connecting the vacuum source at the back of the Interface, the vacuum pipes need to be inserted into the chambers in order for this feature to work properly. The pipes are inserted into the chamber by gently pulling up on the curved part of the pipe, turning it 90° counter- clockwise and gently lowering it into the chamber (as illustrated in "Figure 2.2 - Oxygen supply and suction connection" on page 14). A chamber can then be emptied by pressing the corresponding numbered button. Pressing the "all" button will empty all the chambers at the same time (see "Figure 1.1 - Interface Front Panel with 820MS chambers" on page 11 - "valve buttons").

   NOTE: WHEN DRAINING THE CHAMBERS USING THE AUTOMATIC VACUUM FUNCTION, PRESS THE APPROPRIATE BUTTON FOR AN ADDITIONAL 3-5 SECONDS AFTER THE INITIAL EMPTYING. THIS WILL HELP DRAIN RESIDUAL BUFFER AND SOLUTIONS RETAINED IN THE TUBING AND VALVES.

4. **Chamber covers**
   The chamber covers are used to keep the temperature and other conditions (gas tension, pH) of the solution surrounding the mounted segment as accurate as possible ("Figure 2.3 - Chamber cover" on page 14). Optional stimulation electrodes are available built into the chamber cover and can be used to activate the muscle via field stimulation ("Figure 2.4 - Chamber cover with built-in electrodes" on page 14).

2.3 The first weight calibration

Prior to the shipment of the Muscle Strip Myograph - 820MS it has gone through two days of continuous testing including a final weight calibration. However in order to ensure that the myograph is working at highest performance, DMT recommends that a new weight calibration is performed before starting to use the myograph system. The weight calibration procedure is described in detail in the FORCE CALIBRATION sub-menu under SETTINGS, as explained in chapter 3, on next page.

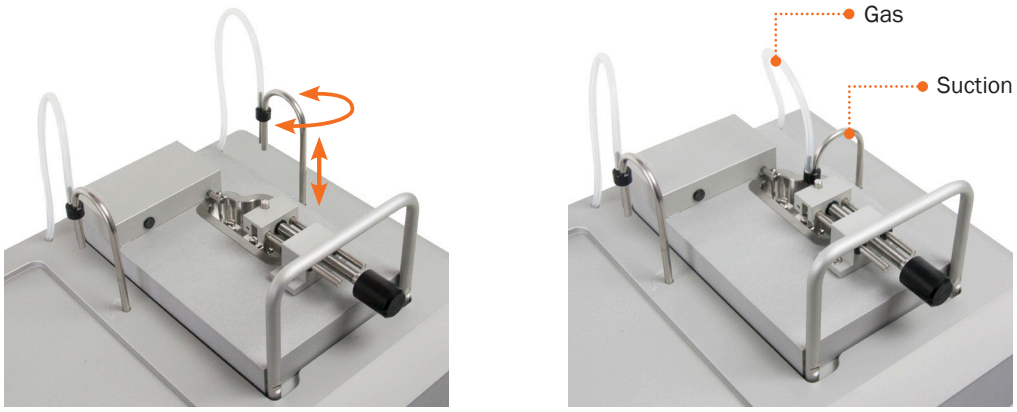


***Figure 2.2** - Oxygen supply and suction connection*

***Figure 2.3** - Chamber cover*

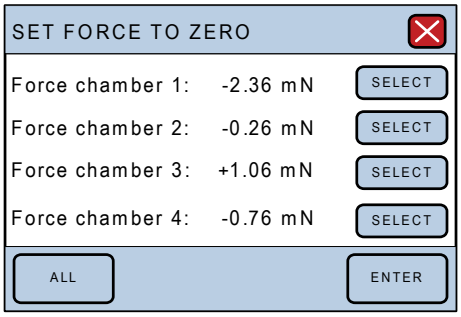
***Figure 2.4** - Chamber cover with built-in electrodes (optional item)*

CHAPTER 3 - THE INTERFACE MENUS

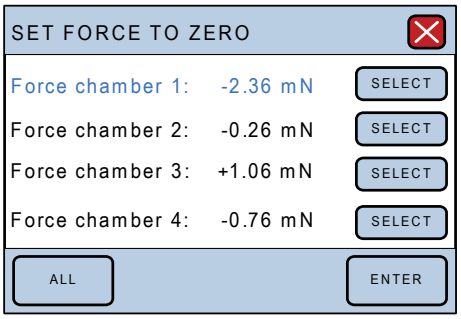
Chapter 3 is a complete manual for the 820MS Interface. This chapter contains a detailed description of how to navigate the touch-screen menus and how to use the special features of the 820MS myograph. The 820MS system can be used in 2 different modes. The first mode is the Calibrated Mode, where the signal from the transducers is filtered and conditioned before the signal is routed to the BNC outputs in the back of the interface for collection by a data acquisition system. The second mode is the Direct Mode, and the signals from the transducers in this mode bypass the internal amplifier and are routed directly to the NBC outputs for data acquisition. Different menu options are available in each mode and will be described in more detail in this chapter.

3.1 Interface Menus – Navigation

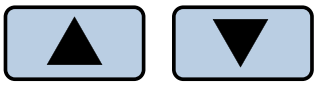
Menus on the 820MS interface are all accessible by a touch screen. To access a menu, simply touch the screen. A setting can be changed by touching the “SELECT” icon on the screen corresponding the “SELECT” icon on the touch screen corresponding to the desired channel to be changed.

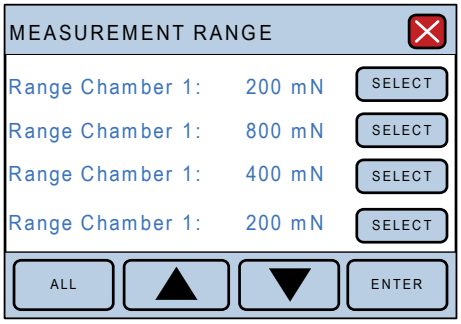


The line to be modified will turn blue, indicating that the interface is waiting for input. When “ALL” is chosen, all lines corresponding to all 4 channels will turn blue. Changing the numeric value for the chosen parameter can be done by touching the up or down arrow keys.



Touch “ENTER” when the desired setting has been chosen. Touching the “X” will exit the menu and automatically take the user to the “ACTUAL FORCE” Display.



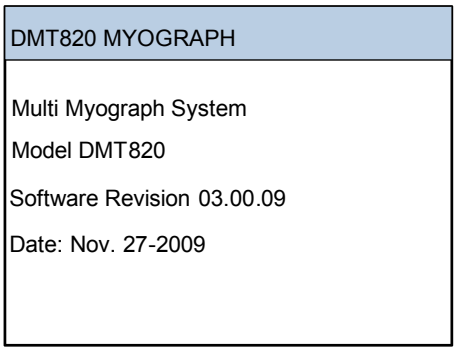


3.2 Interface Menus – Calibrated Mode

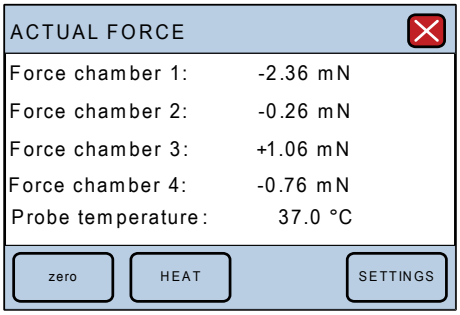
In calibrated mode, the internal amplifier is engaged and signals from the transducer are filtered and conditioned before the signal is sent to a data acquisition system via the BNC outputs on the rear of the interface. The total voltage output from the BNC connectors is 2.5 volts.

Power-Up Screen

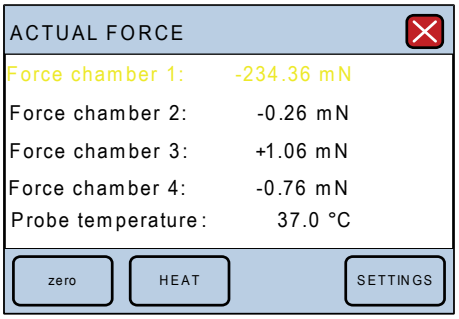
After turning on the 820MS Interface, an “Introduction” screen appears. The system is auto-calibrating the A/D converters while this screen is displayed.



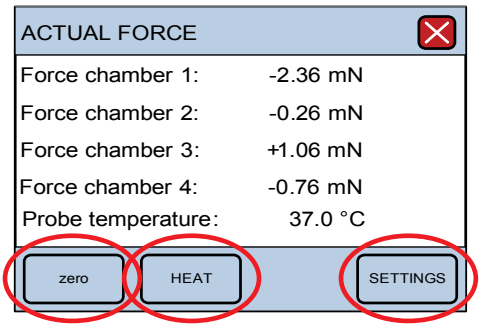
After a few seconds, the “ACTUAL FORCE” display will appear.



At any given time, if the force applied on any channel is out of range, the force reading for the overloaded channel will turn yellow as a warning.

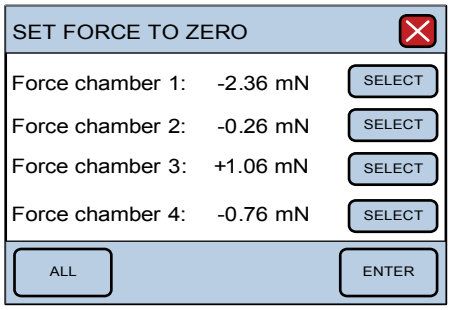


Three menus are accessible from the default “Actual Force” screen or display. These menus are: **Zero**, **Heat**, and **Settings**.



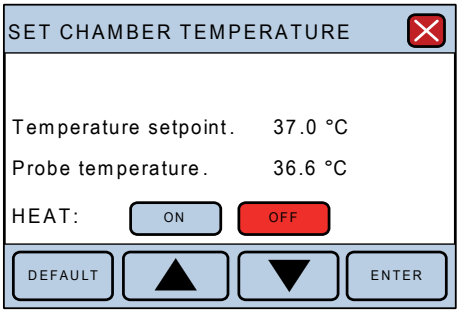
Zero Menu

This menu is used to zero the output of the transducers. When using a data acquisition program like LabChart by AD Instruments ®, using this feature will reset the baseline of the chart traces without affecting the calibrations or physically changing any pre-load tensions placed on the mounted vessels. The channels can be changed individually by pressing “SELECT” or all at once by pressing “ALL”. Pressing “ENTER” will execute the zero function.



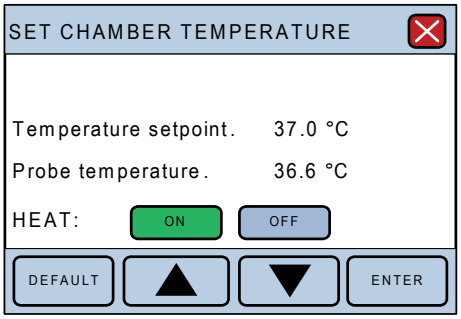
Heat Menu

The heating unit and temperature are controlled from this menu. To turn the heat on or change the preset temperature for the system, access the temperature control menu. Pressing the “HEAT” key will enter the menu and allow the user to change the default system temperature, as well as turn the heat on or off. Pressing “DEFAULT” will automatically reset the temperature setpoint to 37 °C. Manually change the temperature by pressing the up or down arrows.



Turn the heat on by touching “ON” and the icon will turn green.

Pressing the white “X” in the red box will send the user back to the “ACTUAL FORCE” display.

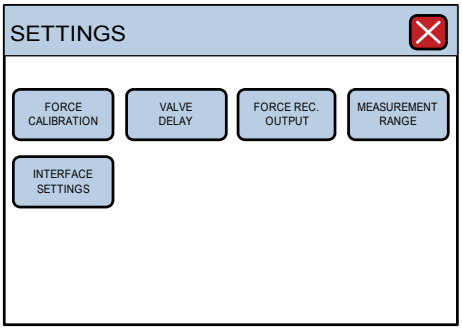


Settings Menu

The “Settings Menu” contains several sub-menus that can be accessed to change functional aspects of the interface. These sub-menus include:

1. FORCE CALIBRATION
2. VALVE DELAY
3. FORCE REC. OUTPUT
4. MEASUREMENT RANGE
5. INTERFACE SETTINGS

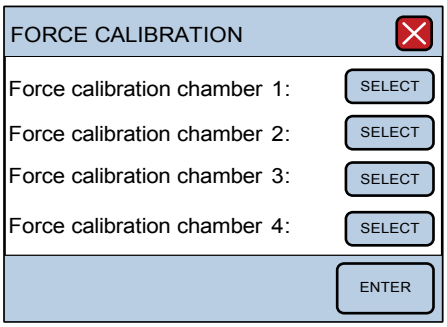
These are the options that are present when the system is in **Calibrated Mode**. Different options will appear when the system is in **Direct Mode**.



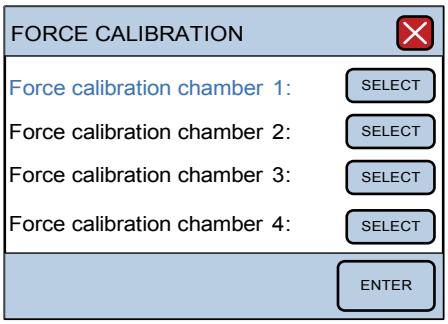
1. Force calibration

NOTE: EVERYTIME A FORCE CALIBRATION IS PERFORMED THE MEASUREMENT RANGE IS SET TO DEFAULT 200 mN. SET MEASUREMENT RANGE AFTER THE FORCE CALIBRATION.

Enter the FORCE CALIBRATION sub-menu to perform the calibration procedure.

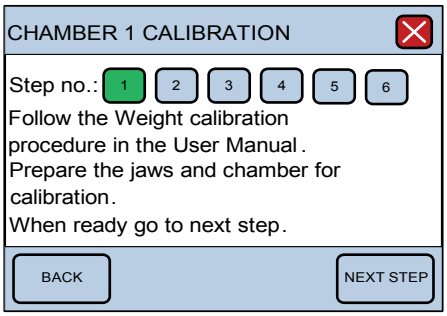


Touch “SELECT” to initiate the calibration for the chosen chamber and the text will turn blue. Touching “ENTER” will start the 6-step procedure for calibrating the chosen force transducer.

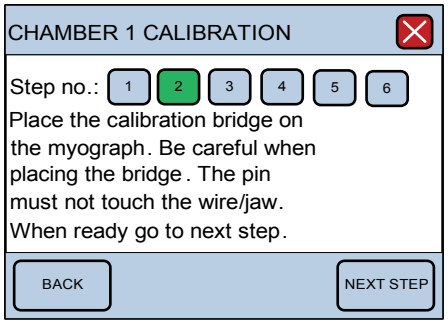


The calibration procedure is listed in 6 individual steps and needs to be performed for each channel or transducer when calibrating the system.

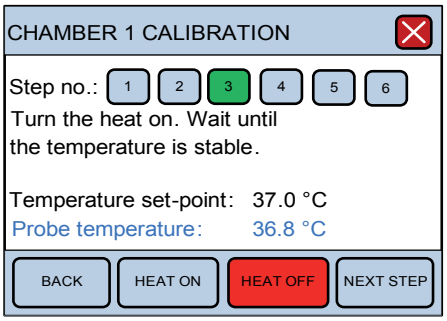
Step 1 involves setting up the chamber for calibration. Make sure the chamber contains the clamp support. Fill the chamber with double-distilled water for the volume to be used experimentally. Press “NEXT STEP”.


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Follow the Weight calibration procedure in the User Manual.
Prepare the jaws and chamber for calibration.
When ready go to next step.
BACK
NEXT STEP

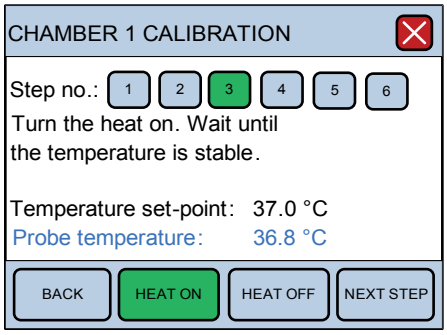
Step 2 involves setting up the calibration kit appropriately for the actual weight calibration. Verify that the transducer arm pin does not touch the clamp support, as instructed. The pin should be as close as possible to the clamp support or mounting pin without touching in order to get the most accurate calibration. Press “NEXT STEP” when the calibration kit has been properly placed.


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Place the calibration bridge on the myograph. Be careful when placing the bridge. The pin must not touch the wire/jaw.
When ready go to next step.
BACK
NEXT STEP

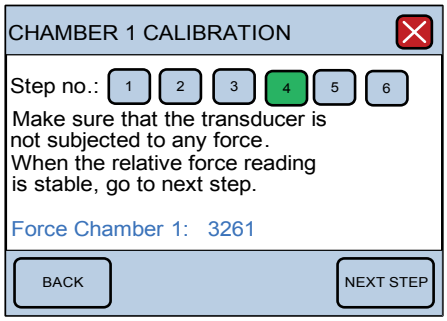
Step 3 Initiates the heating process for the chambers. In order to perform an accurate calibration the transducers must be heated to the desired experimental temperature to accommodate heat-induced expansion of the electronic parts in the transducer. Otherwise inaccurate readings and transducer drift may occur.



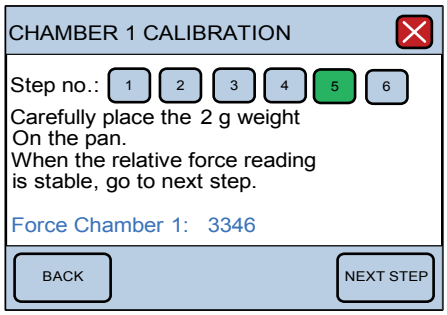
To start heating, press “HEAT ON”. Using the chamber covers will expedite the heating. Place the temperature probe into the first chamber to be calibrated to monitor the temperature. Heating will take approximately 20-30 minutes to reach 37 °C. Press “NEXT STEP” when the chamber(s) has reached the target temperature.



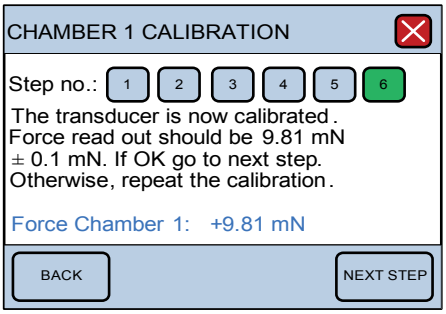
Step 4 is the first step in the actual weight calibration process. A 4-digit number will be displayed in blue at the bottom of the screen. If nothing has been perturbed during the heating process, the zero, 0 gram, or 0.00 mN calibration should be stable as indicated by the 4-digit number and “NEXT STEP” can be pressed at this time. If the 4-digit number is not stable, then wait until the number has stopped fluctuating before pressing “NEXT STEP”.


CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Make sure that the transducer is
not subjected to any force.
When the relative force reading
is stable, go to next step.
Force Chamber 1: 3261
BACK
NEXT STEP

Step 5 is the 2 gram weight calibration. Place the 2 gram weight in the pan closest to the transducer as to simulate a vessel pulling on the clamp attached to the transducer. Remember, a 2 gram weight in a 90° vector is cut in half, and the transducer will only detect 1 gram or 9.81 mN of force. The weight placement should cause a positive increase in the 4-digit number. Wait at least 10 to 15 seconds for the applied force to stabilize before pressing “NEXT STEP”. Once the 4-digit number has stabilized, press “NEXT STEP”.

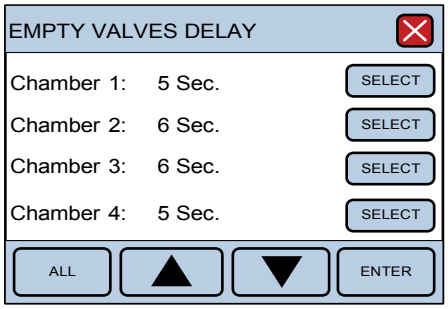

CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
Carefully place the 2 g weight
On the pan.
When the relative force reading
is stable, go to next step.
Force Chamber 1: 3346
BACK
NEXT STEP

Step 6 is to verify that the calibration was performed correctly. The “Force Chamber 1” reading should be 9.81 ± 0.1 mN. If the “Force Chamber 1” reading is off by more than 0.1 mN, then remove the weight, press “BACK” to return to Step 4, and repeat the calibration process. If the “Force Chamber 1” reading is satisfactory, then press “NEXT STEP”. Calibrate the other chambers in the same manner.

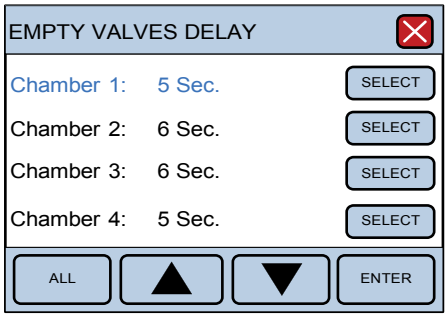

CHAMBER 1 CALIBRATION
Step no.: 1 2 3 4 5 6
The transducer is now calibrated.
Force read out should be 9.81 mN
± 0.1 mN. If OK go to next step.
Otherwise, repeat the calibration.
Force Chamber 1: +9.81 mN
BACK
NEXT STEP

2. Valve delay:

Pressing “VALVE DELAY” in the SETTINGS menu will allow the user to modify the time duration that the vacuum valves stay open for washes. Factory default is set at 1 second, but 1 second is not enough time to completely empty a chamber with even as small a volume of 5 ml.

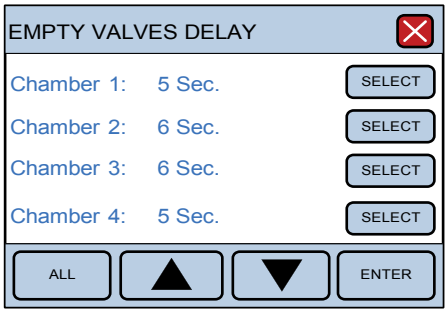


Pressing “SELECT” next to any given channel will cause the line selected to turn blue. The up and down arrow keys can then be used to modify the length of time the vacuum valves stay open after the valves have been activated with the push buttons on the front panel of the interface.



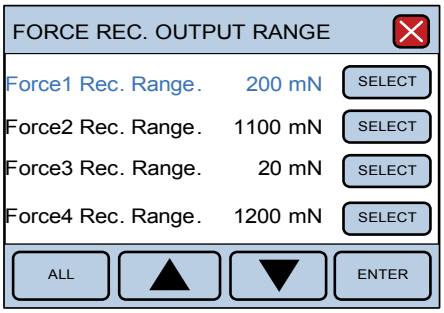
Pressing “ALL” will cause all the lines to turn blue, meaning all chambers can be modified at the same time. Again, the up and down arrow keys can be used to modify the length of time the vacuum valves stay open.

Pressing “ENTER” after modifying the value(s) for valve delay will lock in the number(s) and be retained in memory every time the system is turned on.

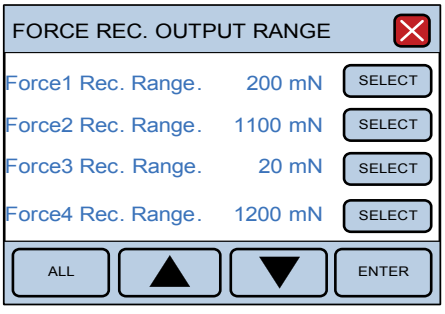


3. Force Rec. out:

The FORCE RECORDING OUTPUT, or FORCE REC. OUT, sub-menu determines the upper limit for force sent from the BNC analogue output connectors. This will only affect the data collected from the interface to a data acquisition system such as AD Instruments PowerLab and LabChart software. The factory default setting for FORCE REC. OUT is 20 mN, meaning that if the force of the mounted vessel exceeds 20 mN, the force recorded in the data acquisition software will not record more than 20 mN and will appear as a flat-line trace at 20 mN, even though the force readings on the interface may exceed 20 mN. Therefore, change the FORCE REC. OUT settings to an appropriate setting so as to capture any maximal response from the vessel of interest. This value should not exceed the settings for the transducer range, which is defined by the sub-menu, MEASUREMENT RANGE and is explained in the next section.



The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will store the numbers in memory for future experiments.

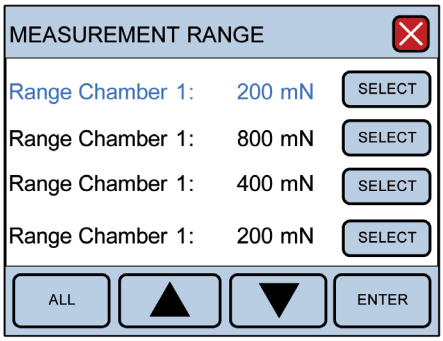


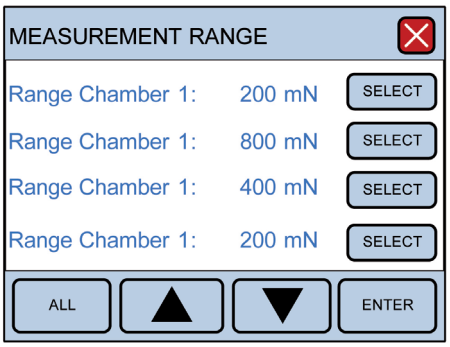
NOTE:
ANYTIME FORCE REC. OUT IS CHANGED, A NEW WEIGHT CALIBRATION OF THE TRANSDUCERS SHOULD BE PERFORMED, ENTERING THE NEW VOLTAGE VALUES INTO THE DATA ACQUISITION SYSTEM BEING USED.

4. Measurement Range:

The MEASUREMENT RANGE sub-menu in SETTINGS determines the maximum force capacity of the transducer. The factory setting is 200 mN, but the transducer capacity can be changed to 400 mN, 800 mN or a maximum of 1600 mN of force detection, depending on the size of the vessel used.

The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will store the numbers in memory for future experiments.

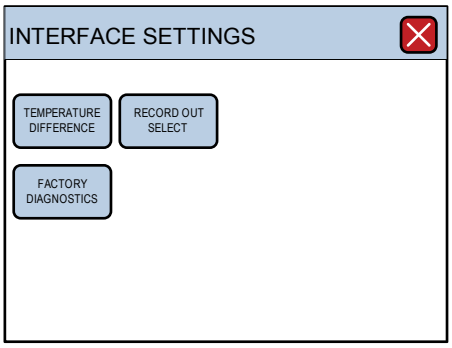




5. Interface settings:

The INTERFACE SETTINGS sub-menu in SETTINGS has an additional 3 sub-menus. These 3 additional sub-menus are:

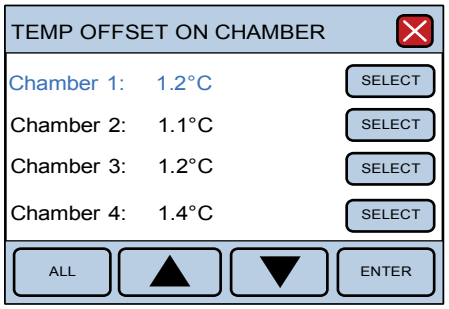
I. TEMPERATURE DIFFERENCE
II. RECORD OUTPUT SELECT
III. FACTORY DIAGNOSTICS

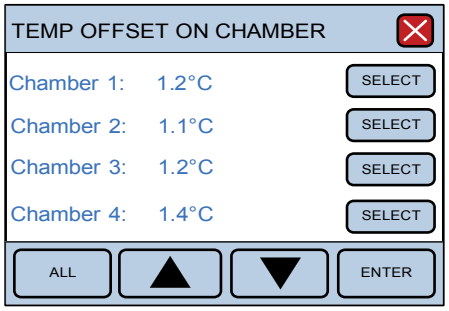


I. TEMPERATURE DIFFERENCE:

The TEMPERATURE DIFFERENCE function allows the user to finetune the temperature setpoint of the system. Although the temperature setpoint for the system can be set in the **HEAT MENU**, the actual temperature for the system may not heat to the exact defined setpoint. The exact temperature in the bath can be measured using the external temperature probe. Therefore, the user can adjust the temperature of each chamber individually to fine-tune the temperature setting so that EXACT temperatures can be achieved for any particular chamber. This is referred to as a temperature offset (TEMP OFFSET ON CHAMBER).

The “SELECT” and “ALL” functions are the same in this menu as previously described for the “VALVE DELAY” menu. Pressing “ENTER” will store the numbers in memory for future experiments.

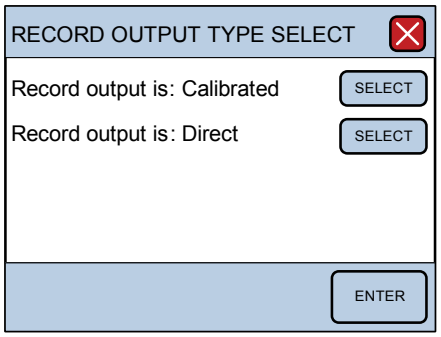




II. RECORD OUTPUT SELECT

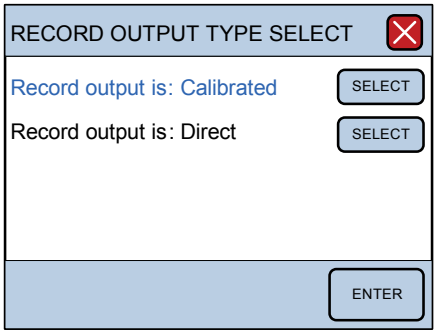
The RECORD OUTPUT SELECT option allows the end-user to select the signal output from the transducers. This option deals with how the signal from the transducers to the BNC outputs are handled and routed. The 2 options are:

1. Record output is: Calibrated
2. Record output is: Direct



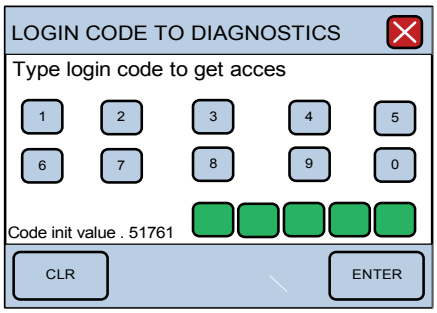
To select the type of output, press SELECT. The text selected will appear in blue. To finish the selection, press ENTER, and the system will change to the desired output.

When the calibrated output is selected, the signal from the transducer is being routed through the internal amplifier before the signal is passed to the BNC outputs on the rear of the interface for data acquisition. The voltage from the BNC outputs in the Calibrated Mode is 2.5 volts.



III. FACTORY DIAGNOSTICS

Entering FACTORY DIAGNOSTICS will display the LOGIN CODE TO DIAGNOSTICS window. This window is for trained technicians and used for diagnostics and troubleshooting purposes. The general user will not have access to this window. Entering the proper 5-digit pin number, however, will allow the trained technician access to Diagnostics panels that will provide information during a malfunction or mechanisms to change other settings controlled by the onboard computer.

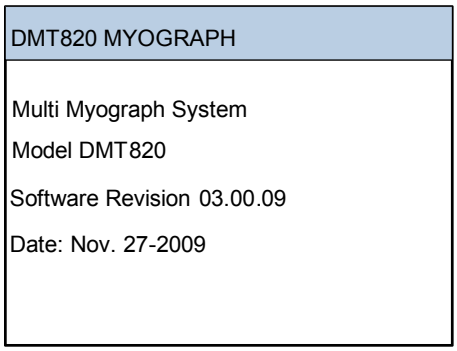


3.3 Interface Menus – Direct Mode

In direct mode, the signals from the transducer are transmitted directly to a data acquisition system via the BNC outputs on the rear of the interface. The signals produced from the transducers are not processed (not channelled through an amplifier). The total voltage output from the BNC connectors is ±2.5 volts and the effective force range will be 600mN.

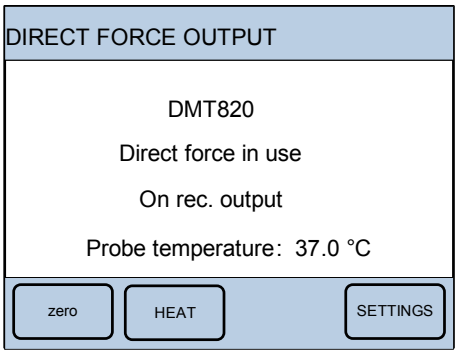
Power-Up Screen

After turning on the 820MS Interface, an “Introduction” screen appears.



After a few seconds, the DMT 820MS Direct Force Output display will appear. When in Direct Mode, the ACTUAL FORCE display will not be shown, as is the case when the system is in the Calibrated Mode (see “3.2 Interface Menus – Calibrated Mode” on page 16).The force readings will only be available in the data acquisition system connected via the BNC outputs.

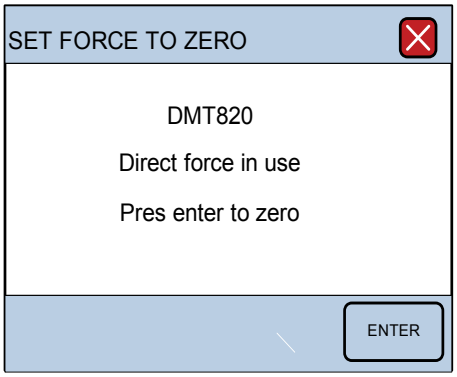
Many of the menus in the Direct Mode will be similar to those in the Calibrated Mode. When Direct Mode is selected, certain menus in the SETTINGS MENU that existed in Calibrated Mode do not exist in the Direct Mode.



Zero Menu (Direct Mode)

This menu is used to zero the output of the transducers. When using a data acquisition program like LabChart by AD Instruments ®, using this feature will reset the baseline of the chart traces without affecting the calibrations or physically changing any pre-load tensions placed on the mounted tissues.

Pressing “ENTER” will execute the zero function and return the user to the DIRECT FORCE OUTPUT display. All 4 channels will be reset to zero at the same time. There is no option to zero each channel individually.



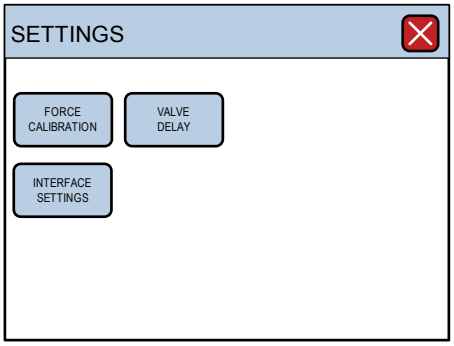
Settings Menu (Direct Mode)

The “Settings Menu” contains several sub-menus that can be accessed to change functional aspects of the interface. These sub-menus include:

1. FORCE CALIBRATION
2. VALVE DELAY
3. INTERFACE SETTINGS

The options, FORCE REC OUTPUT and MEASUREMENT RANGE are no longer available in Direct Mode.

All other menus function the same way in Direct Mode as described for Calibrated Mode. Calibration of the force transducers is performed in a similar manner as described in “3.2 Interface Menus – Calibrated Mode” on page 16, FORCE CALIBRATION. However, no force values will be given during the calibration, and voltages corresponding to zero and calibration weight used will have to be entered into the data acquisition.



CHAPTER 4 - THE MUSCLE STRIP MYOGRAPH UNIT

Chapter 4 contains a complete explanation of how to calibrate and maintain the 820MS myograph to ensure the equipment is always performing at peak performance. This Chapter also covers the mounting supports and how to mount a muscle strip in the 820MS chamber.

4.1 Calibration of the force transducer

As a part of the general maintenance of the myograph, DMT recommends that the myograph is **weight-calibrated at least once a month**. The myograph should also be weight-calibrated every time the interface has been moved. Although lab benches are all supposedly perfectly horizontal, small differences in lab bench pitch can affect the calibration of the system. The myograph also should be calibrated if the system has been idle for longer than a month. A step-by-step procedure is included in the FORCE CALIBRATION sub-menu under SETTINGS, as explained in “Chapter 3 - The Interface Menus” on page 15.

NOTE: CHECK TO SEE IF CALIBRATION IN DIRECT MODE IS DIFFERENT

Force transducer calibration procedure

This section contains step-by-step instructions to calibrate the force transducer. This section will contain 2 sets of calibration instructions. The 1st set of instructions will be for calibrating the 820MS system while in CALIBRATED MODE and should be used in conjunction with the steps described in “3.2 Interface Menus – Calibrated Mode” on page 16 (FORCE CALIBRATION sub-menu under SETTINGS). The 2nd set of instructions will be for calibrating the 820MS system while in DIRECT MODE (see ”3.3 Interface Menus – Direct Mode” on page 22).

NOTE: EVERYTIME A FORCE CALIBRATION IS PERFORMED THE MEASUREMENT RANGE IS SET TO DEFAULT 200 mN. SET MEASUREMENT RANGE AFTER THE FORCE CALIBRATION.

Calibration procedure in CALIBRATED MODE

The following calibration procedure is recommended if the tissue of interest will be producing relatively small forces. For example, muscle strips that may potentially be producing forces that do not exceed 20mN, then the FORCE REC. OUTPUT and MEASUREMENT RANGE options should be set appropriately (see “3.2 Interface Menus – Calibrated Mode” on page 16). As an example, FORCE REC. OUTPUT should be sent to 30mN, MEASUREMENT RANGE should be set to 200mN, and the following calibration procedure using the supplied 2g weight should be followed:

1. Move the mounting supports apart. Fill the chamber with distilled water or buffer. Use the same volume that will be used during the experiments.

2. Set up the calibration kit (bridge and balance) on one of the myograph chambers as illustrated in “Figure 4.1 - 4.2 Weight calibration kit shown in place on a single myograph chamber” on page 25. Turn the heat on as discussed in Chapter 3.1. The system takes about 20 to 30 minutes to reach 37 °C. For skeletal muscle preparations, most likely experiments will be performed at room temperature. It is recommended that the system temperature be set to 25 to 27 °C so that experiments are performed at a constant temperature, depending on the temperature regulation in the room the myograph is set up in.

   Obviously, lower temperatures take less time and higher temperatures take more time to reach. Make sure adequate time is allowed so that calibration can be performed at the temperature at which the experiments will be performed. Placing the calibration kit and weight on the chamber allows them to warm up to the experimental target temperature. No need to bubble the chambers while waiting for the system to heat up.

3. When the system reaches target temperature, adjust the calibration kit so that the tip of the transducer arm is as close to the mounting support on the transducer side as possible without touching. One way to do this is to use the following technique. Start with the calibration kit in place so that the transducer arm of the bridge with the pans is not touching any part of the mounting support. Go to the main menu displaying the forces, and zero the channel being calibrated so the force reads zero. Slowly and gently slide the calibration kit forward toward the micromanipulator so that the transducer arm rests on the mounting support, creating a force reading on that channel. Carefully slide the calibration kit back toward the transducer slowly until the force reads zero or very close to zero. At this point, as soon as the force reads zero, the transducer arm will be properly placed for weight calibration.

4. Go to the FORCE CALIBRATION sub-menu of the SETTINGS menu on the Interface to begin the actual transducer calibration. The process that is described above is reiterated in 6 steps once the FORCE CALIBRATION sub-menu is initiated, which is described in detail in “3.2 Interface Menus – Calibrated Mode” on page 16.

Muscle with relative large contractile forces (>200mN)

For muscle strips of interest producing relatively large contractile forces, the following calibration procedure is recommended. For example, muscle strips that may potentially be producing forces around 300 mN, then the FORCE REC. OUTPUT and MEASUREMENT RANGE options should be set appropriately (see “3.2 Interface Menus – Calibrated Mode” on page 16). As an example, FORCE REC. OUTPUT should be to 400mN, MEASUREMENT RANGE should be set to 400mN, and the data acquisition should be calibrated appropriately. If, for example, AD Instruments’ PowerLab and LabChart are being used as the data acquisition, and the settings above are selected in the interface (FORCE REC. OUTPUT = 400mN and MEASUREMENT RANGE = 400mN), then full-scale output from the BNC connectors at the rear of the interface will be 2.5 volts = 400mN. Therefore, in LabChart, one can, under Units Conversion, enter 0 volts for 0mN and 2.5 volts for 400mN. This is possible because the output from the interface has been programmed so that 2.5 volts from the BNC outputs corresponds to whatever the FORCE REC. OUTPUT is set to.

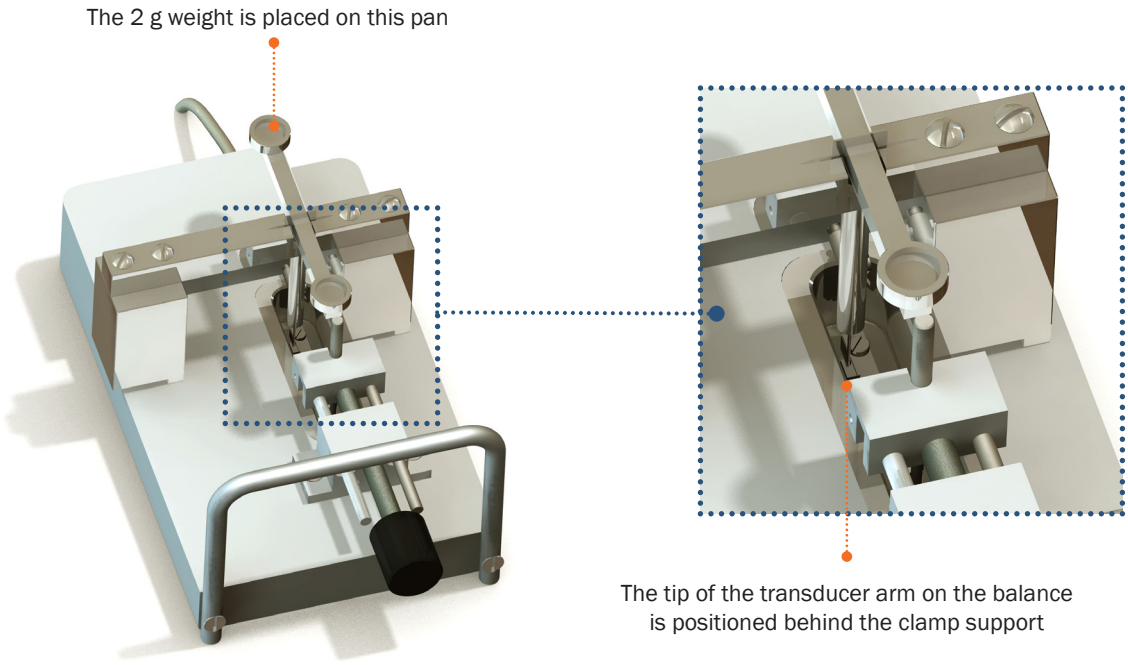


Figure 4.1 - 4.2 *Weight calibration kit shown in place on a single myograph chamber*

4.2 Checking the force transducer

The myograph force transducer is a strain gauge connected to a Wheatstone bridge. The force transducers for each chamber are housed in a separate, protective compartment (see figure 4.3 below). While the protective cover offers some mechanical protection for the force transducers, they are still very vulnerable to applied forces exceeding 1 Newton (100 grams) or fluid running into the transducer compartment due to insufficient greasing of the transducer pinhole (see “Figure 4.6 Close-up of transducer pin from outside” on page 27).

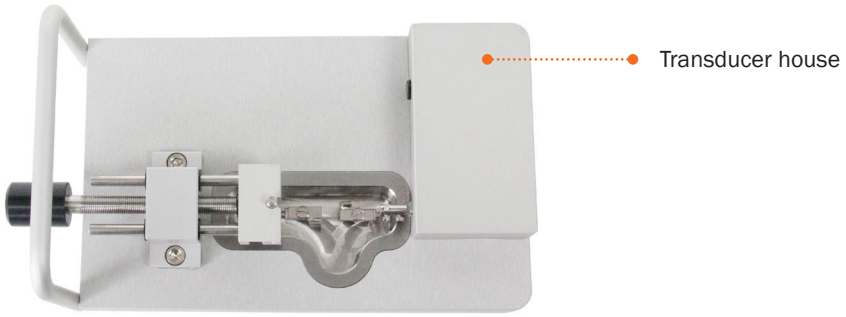


Figure 4.3 *Illustration of the proper transducer house*

If the force readings on the Interface appear **unstable** or **noisy**, then first check that the chambers are connected properly to the Interface and that the chambers are plugged all the way into the interface.

If the force reading(s) are still **unstable** or **noisy**, then perform a new calibration of the force transducer as described in ”Chapter 3 - The Interface Menus” on page 15 and “4.1 Calibration of the force transducer” on page 24.

During the new calibration, monitor the relative force reading values in the FORCE CALIBRATION sub-menu on the Interface (Steps 4 and 5 of the calibration procedure):

- If the value is 0, a single digit, or above 6500, then the force transducer is broken and needs to be replaced.

If the message “OFF” is displayed on the main page of the Interface even though the chamber is plugged in at the rear of the interface, then the force transducer is broken and needs to be replaced. In addition, if the force reading(s) appear yellow in color, cannot be reset to zero, AND the transducer cannot be recalibrated, then the force transducer is broken and needs to be replaced.

If any other problems related to the force transducer are encountered, please contact DMT for advice or further instructions.

4.3 Force Transducer Replacement

If the force transducer breaks and needs to be replaced, follow this step-by-step replacement procedure carefully:

1. Remove the clamp from the transducer pin coming out of the transducer house.
2. Disconnect the Myograph Chamber from the Interface.
3. Turn the Myograph Chamber upside down and remove the transducer housing by loosening the two screws (A+B) as illustrated in “Figure 4.4” below.

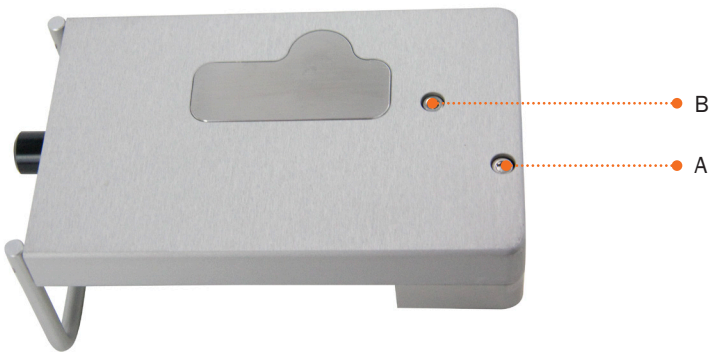


Figure 4.4 - *The 2 screws that secure the transducer house to the chamber*

4. The replacement transducer will be shipped with the new transducer inside a new transducer house.

5. Place a VERY small amount of vacuum grease (clear or whitish grease) around the bottom inside of the transducer housing to seal the transducer housing when put back in place. An arrow in figure 4.5 below indicate the place that the grease needs to be applied.

6. Carefully realign the transducer housing with the new transducer on the Myograph Chamber and reinsert the allen screws through the bottom of the Myograph Chamber.

7. Tighten the screws and place some vacuum grease from the outside around the transducer pin that protrudes from the transducer housing. Make sure that the hole is completely sealed to prevent buffer solution or water from entering the transducer housing and damaging the new force transducer. Arrow in figure 4.6 below indicate the place that the grease needs to be applied.

IMPORTANT:
CALIBRATE THE NEW FORCE TRANSDUCER BEFORE PERFORMING A NEW EXPERIMENT, AS DESCRIBED IN "CHAPTER 3 - THE INTERFACE MENUS" ON PAGE 15 AND "4.1 CALIBRATION OF THE FORCE TRANSDUCER" ON PAGE 24.

Figure 4.5 *The transducer in the transducer housing and close-up of transducer pin inside the transducer*
The arrow indicate the place that the grease needs to be applied to prevent water and buffer from damaging the transducer.

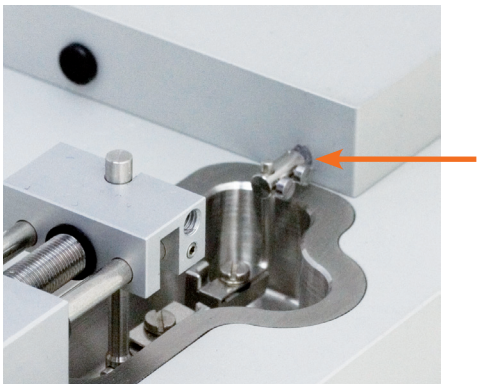


Figure 4.6 *Close-up of transducer pin from outside*
The arrow indicate the place that the grease needs to be applied to prevent water and buffer from damaging the transducer.

4.4 Myograph Maintenance

The Muscle Strip Myograph System - 820MS is a very delicate and sophisticated piece of research equipment. DMT recommends that the following sections are read carefully and that the instructions are followed at all times.

Myograph chamber tubing

To prevent the tubing from becoming blocked with buffer salt deposits after an experiment, remove the chamber cover from the Myograph Chamber. Fill the chamber with distilled water and turn on the vacuum and press the vacuum valve for about 10 seconds by holding down the valve button(s) down. Repeat this at least two times. Press the vacuum valve for about 10 secounds by holding the valve button down to empty chamber and tubes. Turn off the vacuum and gas supply. Remove any water or buffer remaining in the chamber or on the tubing using absorbent paper.

Force transducer

The force transducer is the most delicate and fragile component of the myograph system. Extreme care must be used when handling or touching the force transducers.

As a part of daily maintenance, inspect the grease around the transducer pin extending from the transducer housing pinhole before starting any experiment. Insufficient grease in this area will allow buffer and water to enter the transducer housing and cause damage to the force transducer.

IMPORTANT:

DMT RECOMMENDS THAT THE HIGH VACUUM GREASE SEALING THE TRANSDUCER PINHOLE IS CHECKED AND SEALED AT LEAST ONCE A WEEK, ESPECIALLY IF THE MYOGRAPH IS USED FREQUENTLY.

DMT TAKES NO RESPONSIBILITIES FOR THE USE OF ANY OTHER KINDS OF HIGH VACUUM GREASE OTHER THAN THE ONE AVAILABLE FROM DMT.

DMT TAKES NO RESPONSIBILITIES FOR ANY KIND OF DAMAGE APPLIED TO THE FORCE TRANSDUCERS.

Micromanipulators

Check the micropositioner for **grease at least once a week**. There are 3 main parts that will need to be greased on the micropositioner, those parts being the micropositioner screw thread and the 2 slide bars to the left and right of the micropositioner screw thread. In case of insufficient lubrication, grease the micropositioner with the “Grease for Linear Slides” included with your system. Apply the linear slide grease in the areas indicated by the arrows in figure 4.6 below.

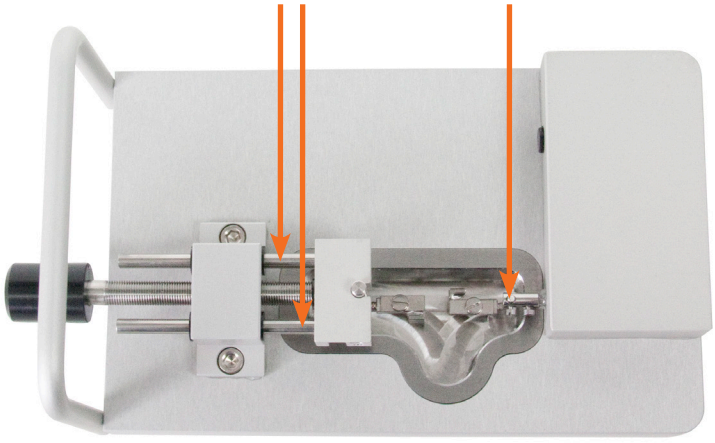


Figure 4.6 *The areas where linear slide grease may be applied for smooth micropositioner movement*

4.5 Cleaning the myograph

DMT strongly recommends that the myograph chambers and surrounding areas are cleaned after each experiment.

At the end of each experiment, use the following procedure to clean the myograph chambers and supports:

1. Fill the myograph chamber to the edge with an 8% acetic acid solution and allow it to work for a few minutes to dissolve calcium deposits and other salt build-up. Use a cotton-tipped applicator to mechanically clean all chamber surfaces.

2. Remove the acetic acid and wash the myograph chamber and supports several times with double distilled water.

3. If any kind of hydrophobic reagents have been used which might be difficult to remove using steps 1 and 2, then try incubating the chamber and supports with 96% ethanol or a weak detergent solution (i.e. 0.1% triton-100).

4. To remove more resistant or toxic chemicals, incubate the myograph chamber and supports with 1M HCl for up to 1 hour. In exceptional cases, incubate the chamber and supports with no stronger than a 3M HNO_3 solution for about 15 minutes.

5. Wash the myograph chamber and supports several times with double distilled water.

6. If acids such as 1M HCl and 3M HNO_3 are used to clean the chambers, make sure ALL surfaces are thoroughly dried after copious washes with double distilled water. Any residual acid will cause corrosion of the stainless steel chamber and/or mounting supports.

IMPORTANT NOTES:

- **BE VERY CAREFUL USING HCL OR HNO_3 BECAUSE THESE ACIDS MAY CAUSE EXTREME DAMAGE TO THE STAINLESS STEEL CHAMBERS AND SUPPORTS, AS WELL AS POSE A SAFETY HAZARD TO THE USER. DO NOT USE BLEACH TO CLEAN THE CHAMBERS. REPEATED USE OF CHLORINATED SOLUTIONS SUCH AS BLEACH AND HCL WILL CAUSE DAMAGE TO THE STAINLESS STEEL PARTS OF YOUR MYOGRAPH SYSTEM. VOID USING THEM IF AT ALL POSSIBLE.**

- **AFTER CLEANING, ALWAYS CHECK THAT THE GREASE AROUND THE TRANSDUCER PIN IS SUFFICIENT TO KEEP THE BUFFER AND WATER FROM ENTERING THE TRANSDUCER HOUSING.**

If red or brown discolorations appear on the chamber sides or on the supports, the following cleaning procedure will work in most cases:

1. Incubate the myograph chamber and supports for 30 minutes with 2mM T-1210 Tetrakis- (2-pyridylmethyl)-ethylenediamine solution dissolved in double distilled water.

2. Use a cotton-tip applicator to mechanically clean all the affected surfaces during the last 15 minutes of the incubation period.

3. Wash the myograph chamber and supports several times with double distilled water.

4. Incubate the myograph chamber with 96% ethanol for 10 minutes while continuing the mechanical cleaning with a cotton-tip applicator.

5. Remove the ethanol solution and wash a few times with double distilled water. Incubate the myograph chamber and supports with an 8% acetic acid solution for 10 minutes and continue the mechanical cleaning with a swab-stick.

6. Wash the myograph chamber and supports several times with double distilled water.

7. Dry the surfaces using absorbent paper (i.e. Kim-Wipes) or cotton-tip applicators.

IMPORTANT NOTES:

IN EXCEPTIONAL CASES, THE SUPPORTS (CLAMP) MAY NEED TO BE REMOVED FROM THE MYOGRAPH CHAMBER AND CLEANED INDIVIDUALLY TO ASSURE PROPER CLEANING OF ALL SUPPORT SURFACES. NEVER SOAK THE SUPPORTS IN ANYTHING STRONGER THAN 8% ACETIC ACID FOR EXTENDED PERIODS OF TIME (I.E. SEVERAL HOURS OR OVERNIGHT)!

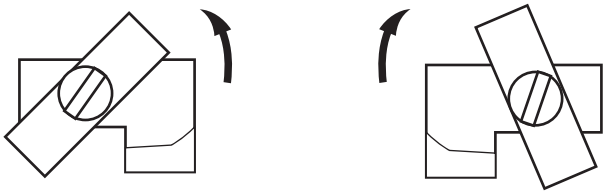
CHAPTER 5 - THE MOUNTING SUPPORTS AND MOUNTING IN THE 820MS CHAMBER

Each chamber contains supports with mounting clamps to facilitate the mounting of muscle strips in the myograph chambers. These clamps have been designed to optimally “clamp” the tissue without slipping during a contraction. They are also designed to effectively “grab” tendon on whole striated muscle preparations without experiencing “slippage” during a whole striated muscle contraction.

1. Starting position.

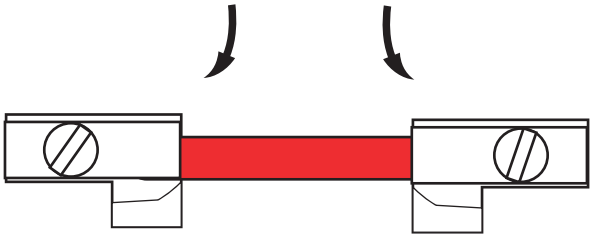
2. Loosen the screws on the mounting clamps.

3. Turn the upper wings of the mounting clamps to expose the base of the support.



4. Place the muscle strip onto the base of the mounting clamp.

5. Turn the upper wings back into position so that the muscle strip is clamped between the wings and base of the mounting clamp.



6. Secure the screws.

IMPORTANT
BE VERY CAREFUL WHEN TIGHTENING THE SCREW ON THE TRANSDUCER SIDE. EXCESSIVE PRESSING DOWN ON THE SCREW OR EXCESSIVE TORQUE FORCE WILL DAMAGE THE FORCE TRANSDUCER.

APPENDIX 1 - SYSTEM SPECIFICATIONS

Technical specifications

Vessel size:	>3 mm - 19 mm
Chamber:	Four individual chambers
Chamber material:	Acid-resistant stainless steel
Chamber volume:	Max. 4 ml
Chamber suction:	Manual or automatic, time controlled, user defined
Chamber cover:	Supplied with connections for gassing
Chamber gassing:	Individually controlled per chamber by needle valves
Force range:	User selectable at ± 200/400/800/1600 mN
Force resolution:	0.1 mN
Weight calibration:	Semi Automatic
Heating:	Built into chamber, independent of superfusion
Temp. range:	Ambient temp. - 45 °C
Temp. resolution:	0.1 °C
Temp. probe:	External
Output reading:	Force (mN)
Analogue output:	Independently filtered or unfiltered (direct) 4-channel output at 2.5V full scale
Voltage:	100 to 240 VAC (auto) 50/60 Hz via external power supply
Ambient temp.:	15-30 °C

Optional accessories

Automatic Buffer Filler System - 625FS
Chamber cover for field stimulation
Combined pulse & train generator - CS200

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DMT A/S
Skejby Science Center
Skejbyparken 152
DK-8200 Aarhus N
Denmark

Tel.: +45 87 41 11 00
Fax: +45 87 41 11 01

www.dmt.dk
sales@dmt.dk
support@dmt.dk

DMT-Asia Ltd.
Rm 2402B, Great Eagle Centre
23 Harbour Road
Wanchai, Hong Kong S.A.R.
P.R. China

Tel.: +852 6621 8337
Fax: +852 3020 7554

www.dmt-asia.com
sales@dmt-asia.com
support@dmt-asia.com

DMT-Asia (China office)
Rm 28C, No. 8 Dong Fang Road
Lu Jia Zui Financial District
Shanghai 200120
P.R. China

Tel.: +86 (0) 21 5425 1330
Fax: +86 (0) 21 5877 0063

www.dmt-asia.com
sales@dmt-asia.com
support@dmt-asia.com

DMT-USA, Inc.
201 East Liberty Street
Suite 6
Ann Arbor, MI 48104
USA

Tel.: +1 770 612 8014
Fax: +1 678 302 7013

www.dmt-usa.com
sales@dmt-usa.com
support@dmt-usa.com

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